Heat Stress and Microclimate Cooling

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Background

- Program Manager, Aircrew Integrated Systems
  - Assessment of Heat Stress of aviators in UH-60 MOPP4 ensembles
    - two temperatures
    - two ensembles, with and without microclimate cooling
  - Physiological and Psychological Effects

Methods

- Subjects
  - 10 U.S. Army helicopter pilots paired as two-man crew.
  - Test subjects volunteered, informed consent.
  - Test subject were medically screened:
    - 12 subjects initially volunteered
    - two subjects eliminated due to pre-existing, disqualifying conditions.

- Procedures
  - 20 minute treadmill walk (3mph, 0 percent grade)
    - environmental chamber
    - simulate pre-flight
  - UH-60 Environmentally Controlled Simulator
    - 2 two hour sorties and one 1 hour sortie
    - Two air assaults and one medical evacuation.
    - Physiological data collected by data acquisition systems.

- Test Design
  - Counterbalanced
  - Two Ensembles
    - Ensemble A : AIRSAVE vest
    - Ensemble B : Seat survival pack

Five Conditions Tested : Each Crew

Condition Tested	Ensemble	Temperature	Microclimate	Cooling
1	A	70 ^{0} F	Yes	
2	A	70 ^{0} F	No	X
3	A	100 ^{0}F	Yes	X
4	A	100 ^{0}F	No	
5	B	70 ^{0}F		Yes
6	B	70 ^{0}F	No	X
7	B	100 ^{0}F		Yes X
8	B	100 ^{0}F	No	X

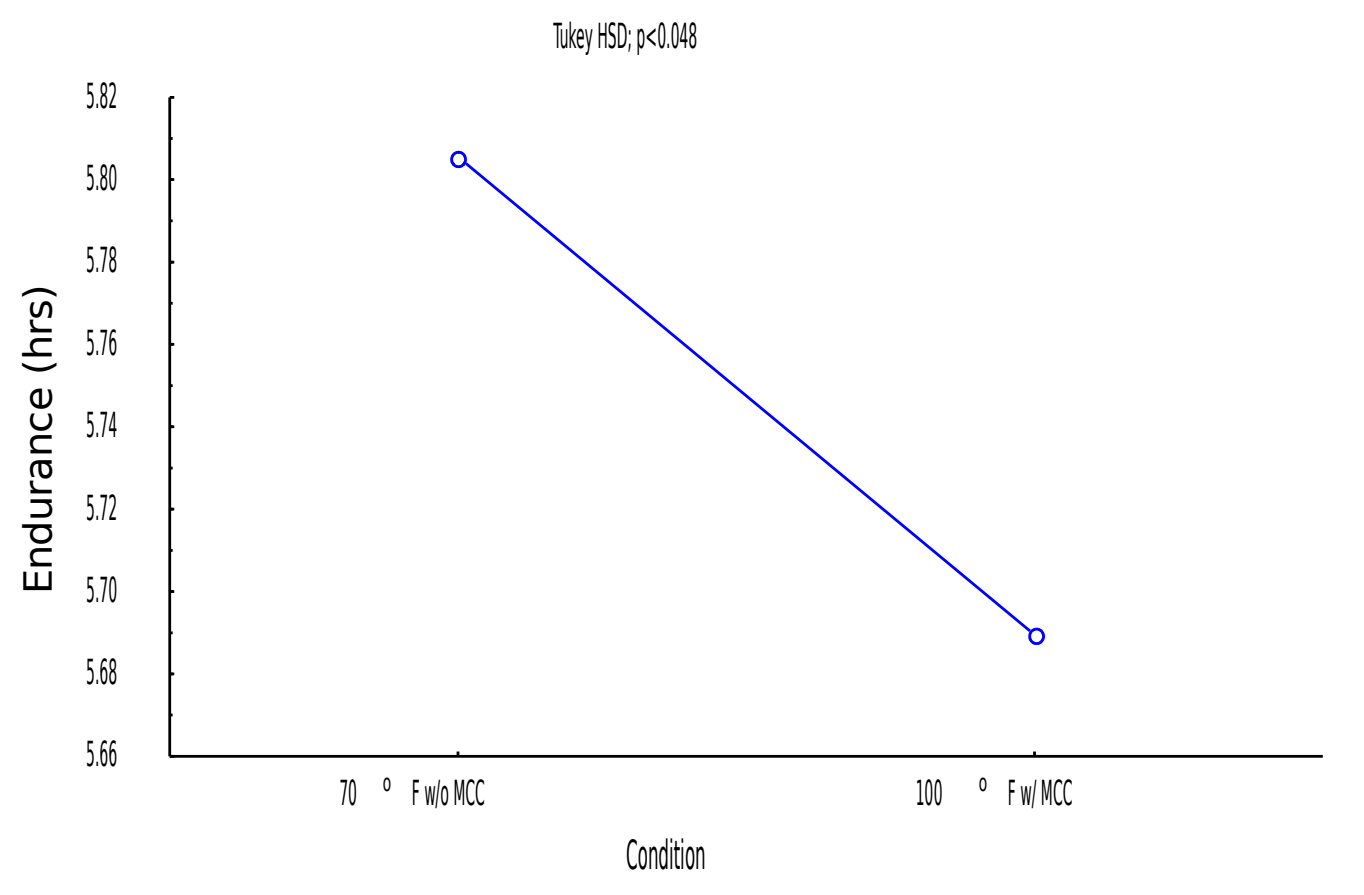
- Objective Physiological Data
  - Heart Rates
  - Core Temperatures
  - Skin Temperatures
  - Fluid intake and loss

- Subjective Psychological Data
  - Mood and Symptoms Questionnaire
  - Hot spot locations, intensities
  - Written feedback : components/overall

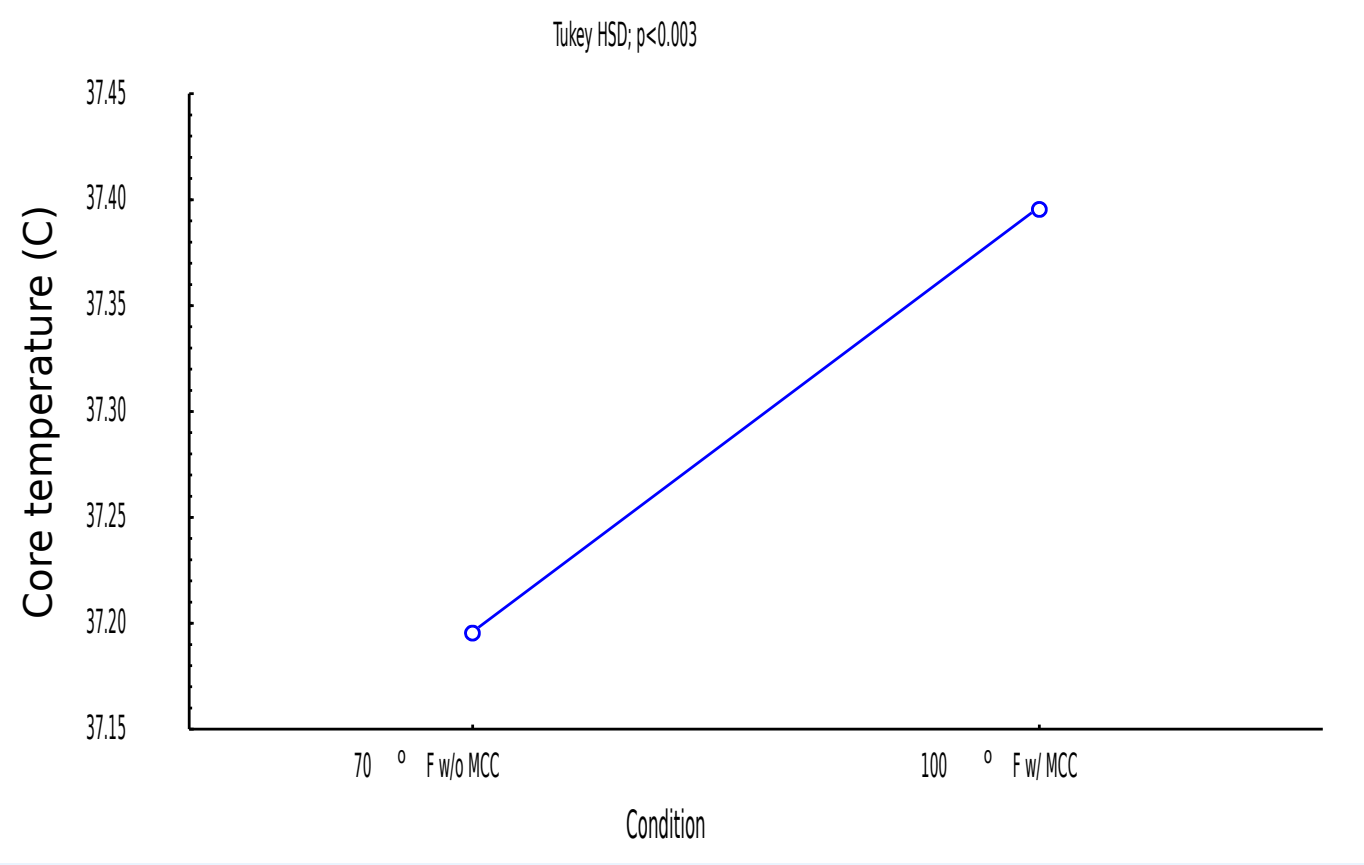
Analyses

- Analysis 1 :
  - Ensemble A vs.. Ensemble B
  - 100^0 F with cooling vs.. 70^0 F without cooling
- Analysis 2 : Ensemble B
  - 70^0 F without cooling (baseline)
    - vs.. 100^0 F with cooling
      - » vs.... 100^0 F without cooling

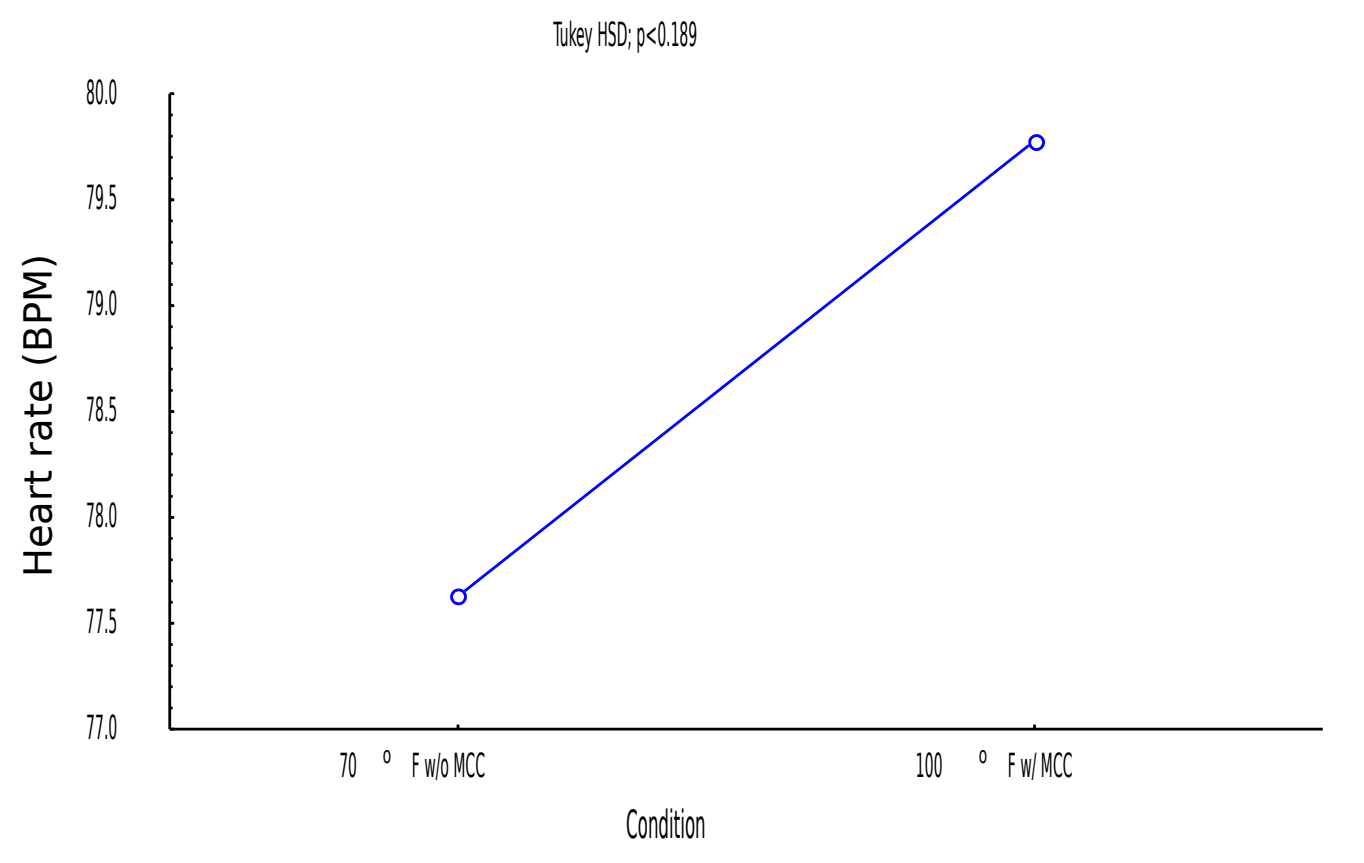
Results
Analysis 1: Endurance



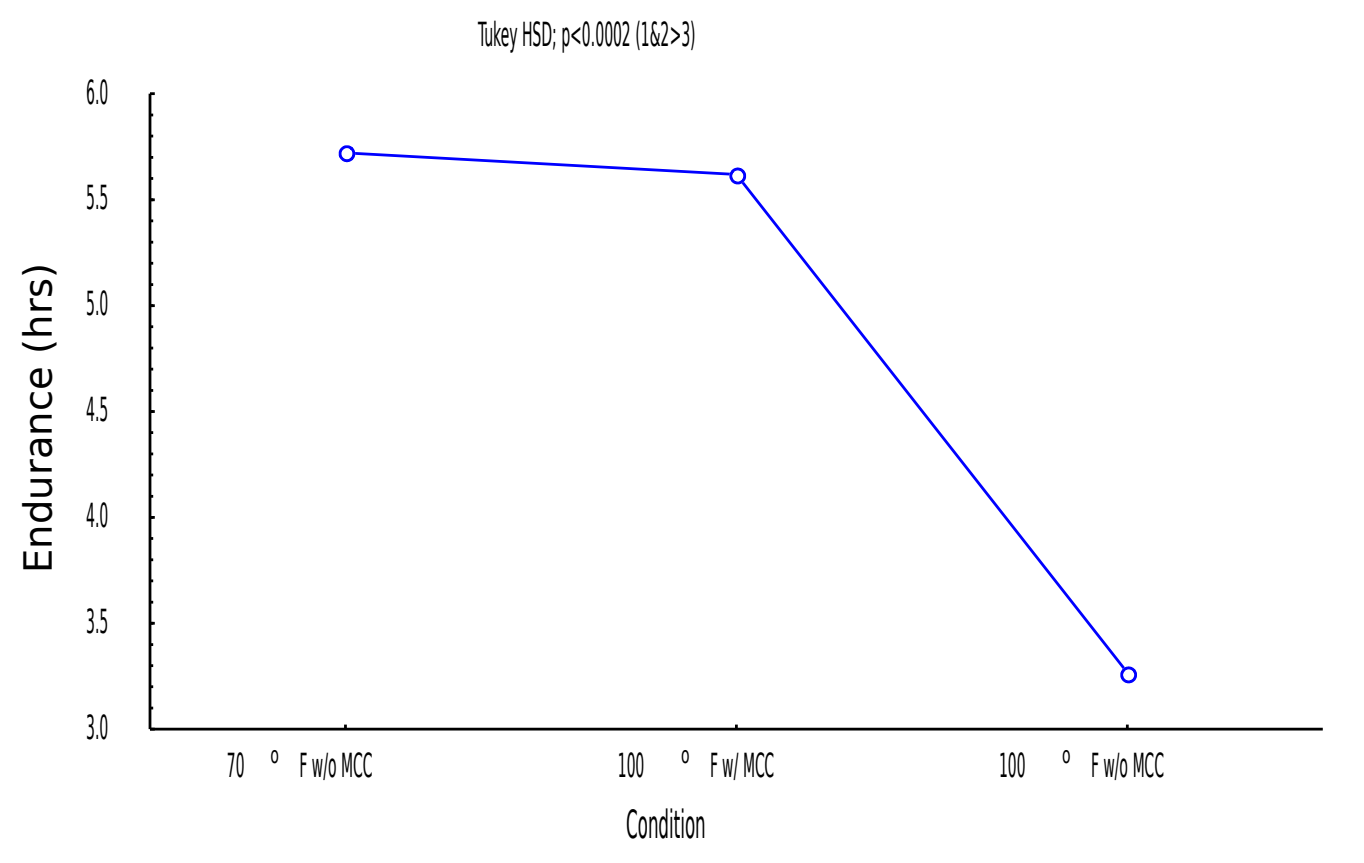
Results (cont.)
Analysis 1: Core Temperature



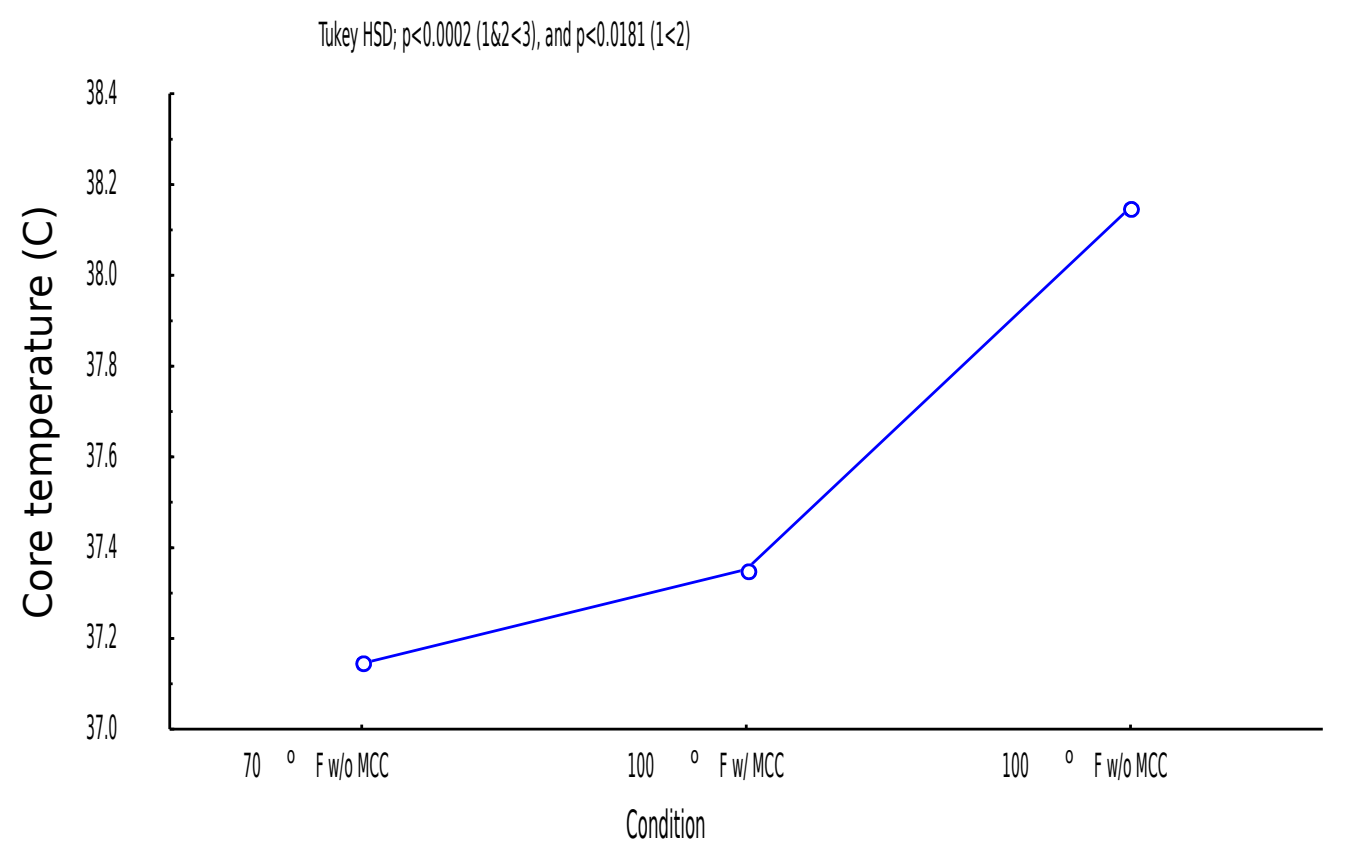
Results (cont.)
Analysis 1: Heart Rate



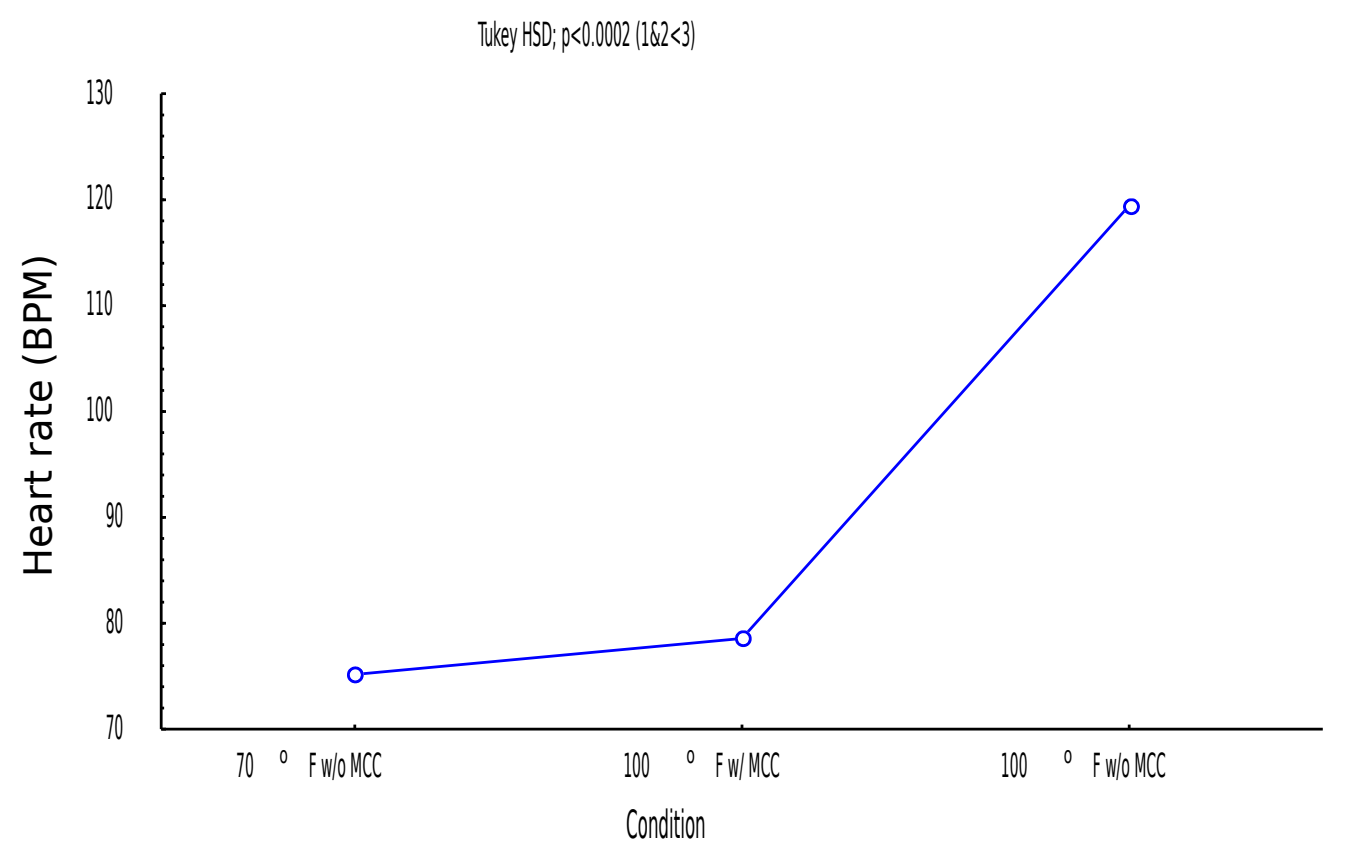
Results (cont.)
Analysis 2: Endurance



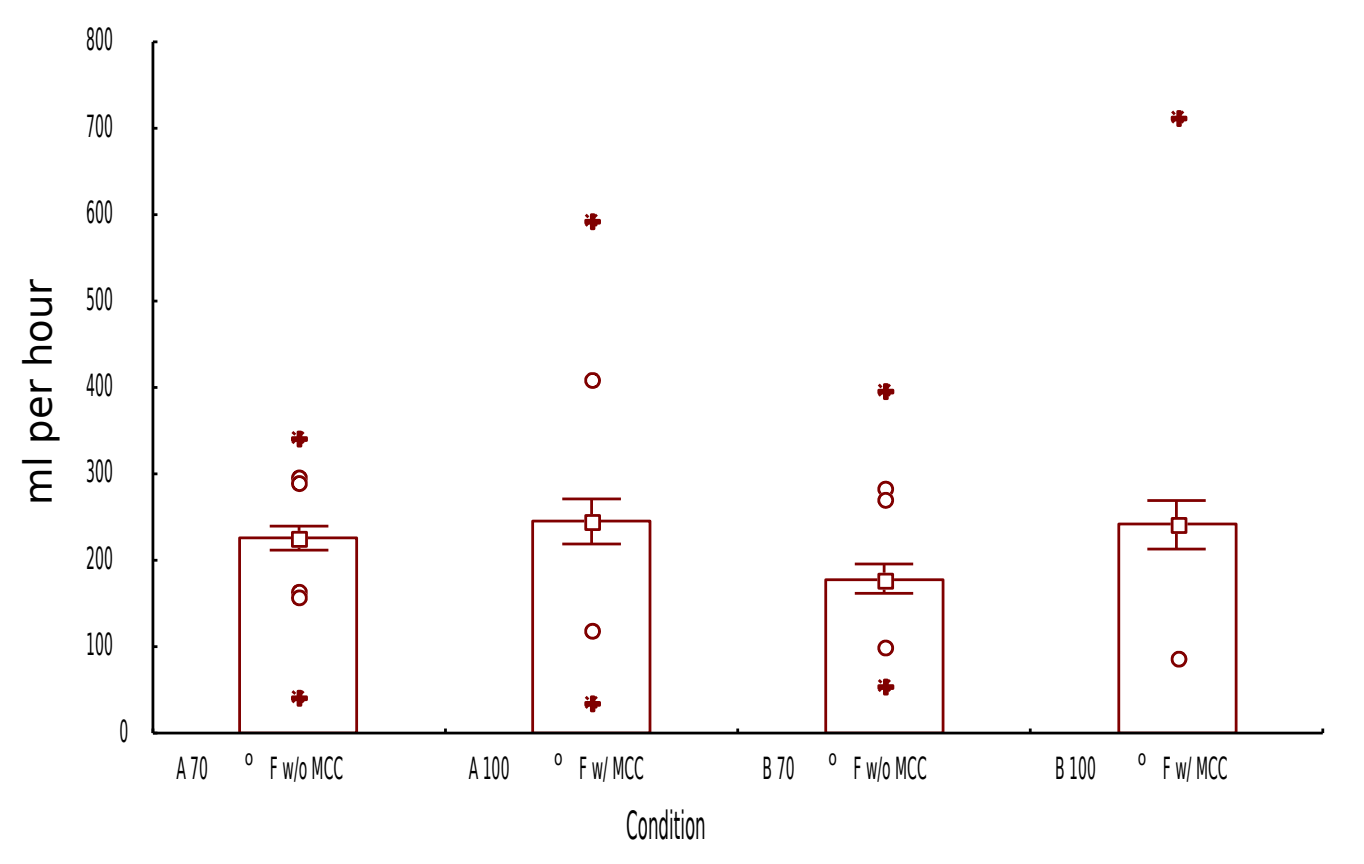
Results (cont.)
Analysis 2: Core Temperature



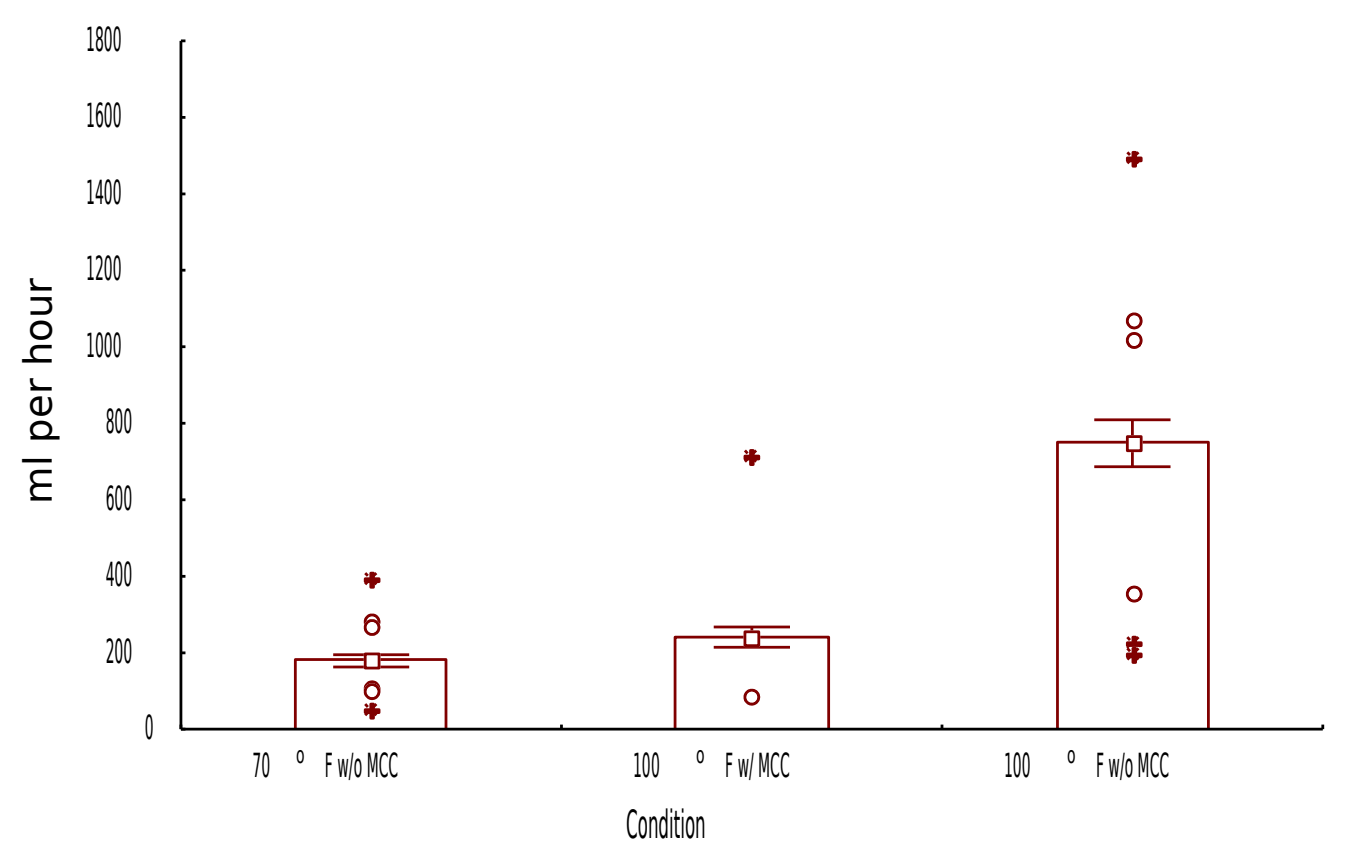
Results (cont.)
Analysis 2: Heart Rate



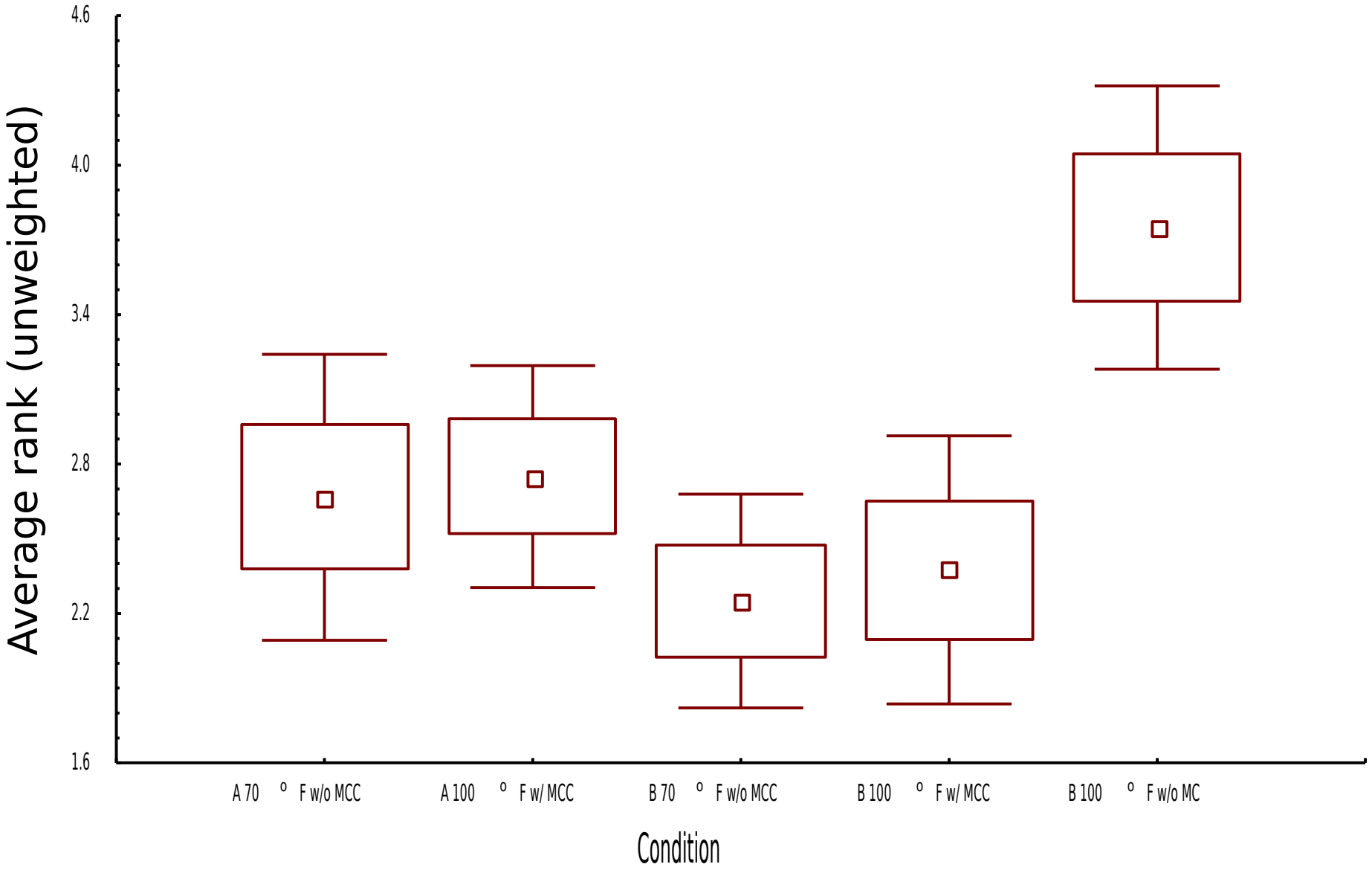
Results (cont.)
Analysis 1: Dehydration Rates



Analysis 2: Dehydration Rates



Mean Ranking of Dependent Measures



Conclusions

- Analysis 1: A significant difference was found between the 70^0F without MCC and the 100^0F
- Analysis 2: Both the 70^0F without MCC and the 100^0F with MCC were significantly different than the 100^0F without MCC

- Ensemble B appears to be the preferred of the two configurations in a hot environment.

- Complaints by test subjects: both ensembles
  - too bulky, making movement difficult
  - mask created pressure on bridge of nose and forehead, effecting extended operations

- Microclimate cooling significantly reduces the effects of heat stress on aviators
  - Microclimate cooling substantiated as an effective method for reducing the physiological and psychological effects of heat stress
  - Greater comfort
  - Greater endurance